

REMARKS

Claims 38 and 45-61 are pending in the present application. In the office action mailed June 3, 2004 (the “Office Action”), claims 38 and 52 were rejected under 35 U.S.C. 102(b) as being anticipated by U.S. Patent 6,001,709 to Chuang *et al.* (the “Chuang patent”). Claims 38 and 45-59 were also rejected under 35 U.S.C. 102(e) as being anticipated by U.S. Patent No. 6,130,102 to White, Jr. *et al.* (the “White patent”).

Embodiments Disclosed in the Present Application

The embodiments disclosed in the present application will now be discussed in comparison to the cited references. Of course, the discussion of the disclosed embodiments, and the discussion of the differences between the disclosed embodiments and the cited references, do not define the scope or interpretation of any of the claims. Instead, such discussed differences merely help the Examiner appreciate important claim distinctions discussed thereafter.

The present invention includes embodiments directed to processes and devices including selectively formed contacts for electrically interconnecting components on an integrated circuit. The contacts have an increased vertical growth rate relative to a lateral growth rate during formation of the contacts. In this way, adjacent contacts may be formed in integrated circuits having reduced dimensions of components forming the integrated circuit since the lateral growth rate of the contacts will not cause adjacent contacts to electrically short circuit. Figure 2 of the present application illustrates an overall process of selectively forming contacts 200-204 on a substrate 206 according to one embodiment of the present invention. To begin the process, a selective epitaxial growth (SEG) process is started, causing the contacts 200-204 to begin forming over the regions 214-218, respectively. At the same time, electromagnetic radiation 208, or some other type of directed thermal energy, is applied to begin heating upper surfaces 220 of the contacts 200-204. The radiation 208 heats the upper surfaces 220, causing a vertical growth rate 226 of each contact 200-204 to increase relative to a lateral growth rate 228 of the contact. The lateral growth rates 228 of each contact 200-204 do not increase significantly because the intensity of the radiation on sidewall surfaces 222, 224 is small relative to the intensity on the upper surfaces 220. As a result, the contacts 200-204 grow at a faster rate in the vertical direction 226 than in the lateral direction 228. The relatively smaller lateral growth rate

228 results in less lateral growth of each contact 200-204 during the time the contact is being formed. The reduced lateral growth rate 228 relative to the increased vertical growth rate 226 enables contacts 200-204 to be selectively formed having a desired height H in semiconductor integrated circuits having reduced lateral spacing between devices. As seen in the example of Figure 2, the reduced lateral growth of the contacts 200 and 202 results in the contacts being formed only slightly over the isolation oxide region 210, while the increased vertical growth rate 226 enables the contacts to be grown to the desired height H. In Figure 2, the surfaces that are significantly heated by the applied radiation 208 are indicated via the thicker lines.

Accordingly, each contact 200-204 exhibits a curved upper surface 220 and the sidewall surfaces 222, 224 that are substantially perpendicular to the substrate 206. Thus, the resulting contact 200-204 exhibits a structure that is different than that of a conventionally formed contact shown in Figure 1.

Cited References

The Examiner has cited the Chuang patent. The Chuang patent describes a semiconductor process directed to the formation of an isolation region formed from a local oxidation of silicon (LOCOS) technique. As described in the background of the Chuang patent, the conventional thermal LOCOS process results in a silicon isolation region having “bird’s beak,” and also causes a thinning of the oxide layer resulting in a “white ribbon effect” at the edges of the active regions formed subsequent to the oxide isolation regions. The process described in the Chuang patent utilizes a patterned “shielding layer” and the implantation of oxygen ions at a tilt angle in the formation of the LOCOS isolation regions. A thermal oxidation process is performed following implantation. *See* col. 3, lines 19-64 and Figures 2A-2C. As shown in Figure 2D and described at col. 3, line 65-col. 4, line 24, the resulting oxide isolation regions do not exhibit the same bird’s beak effect as in conventional LOCOS processes and do not protrude from the surface of the substrate to the same extent as in conventional LOCOS processes. The material cited by the Examiner in col. 3, lines 19-64 and Figures 2A-2C, is directed to the formation of the LOCOS regions and does not disclose the formation of contact regions or of active regions. In fact, the Chuang patent fails to contemplate a structure having any contact regions at all or the formation of active regions. The layers 21 and 22 represent a shielding layer, and are not selectively formed contacts nor are they analogous to them. The

shielding layer, as described in the Chuang patent, provides an implantation mask for the oxygen ion implantation process and are ultimately removed following the formation of the LOCOS regions.

The Examiner has also cited the White patent. The White patent is directed to a semiconductor process for forming a lower capacitor electrode for a ferroelectric dynamic random access memory (DRAM) and a metallic conductive plug region. The material cited by the Examiner, namely, col. 3, lines 24-67 and Figure 2, is directed to the formation of oxide isolation regions and a gate structure. As described in the White patent, the gate structure includes a gate dielectric layer 18 formed over an active region. Formed on the gate dielectric layer 18 is a gate electrode layer 20, which can be made from one or more layers of polysilicon or amorphous silicon. The sidewalls of the gate electrode are oxidized to form an oxide layer 22, and silicon nitride spacers 24 formed overlying the oxide layer 22.

The Chuang patent and the White patent do not disclose or fairly suggest an epitaxially grown contact structure having a curved upper surface and sidewalls that are substantially perpendicular to the underlying substrate.

Claims and Rejections

Turning now to the claims, the patentably distinct differences between the cited references and the claim language will be specifically pointed out. Claim 38 recites “a selectively formed contact epitaxially grown on each contact region, each contact being isolated from contacts on adjacent contact regions, each contact having a curved upper surface intersected by two sidewall surfaces, the two sidewall surfaces being substantially perpendicular to the surface of the substrate.” Neither the Chuang patent nor the White patent disclose or fairly suggest the above limitations. Neither reference discloses epitaxially grown contacts having the structure as defined by the above limitations. Claims depending from claim 38 are also allowable due to depending from an allowable base claim and further in view of the additional limitations recited in the dependent claims.

Claim 52 recites “at least one selectively formed contact epitaxially grown on each active region, each selectively formed contact being isolated from contacts on adjacent active regions, each selectively formed contact having a curved upper surface intersected by two sidewall surfaces, the two sidewall surfaces being substantially perpendicular to an upper surface

of the active region." Neither the Chuang patent nor the White patent disclose or fairly suggest the above limitations. Neither reference discloses epitaxially grown contacts having the structure as defined by the above limitations. Claims depending from claim 52 are also allowable due to depending from an allowable base claim and further in view of the additional limitations recited in the dependent claims.

The Applicant disagrees with the Examiners assertion that the limitation "selective epitaxial growth" recited in claim 57 is a process limitation. The limitations "epitaxial growth" or "epitaxially grown" defines a structural relationship between the contact and the underlying substrate that it is grown on. As known in the art, epitaxy is the growth of a thin layer on the surface of a crystal so that the layer has the same structure as the underlying crystal. Thus, there is a structural relationship between the epitaxially grown layer and the underlying substrate.

All of the claims pending in the present application (claims 38 and 45-61) are in condition for allowance. Favorable consideration and a timely Notice of Allowance are earnestly solicited.

Respectfully submitted,

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